CLAIMS

Therefore, having thus described the invention, at least the following is claimed:

1. An input/output (I/O) interconnect system, comprising:

a first substrate having at least one compliant pillar transversely extending from the first substrate, wherein the compliant pillar comprises a first material, and wherein the compliant pillar includes a non-flat tip at the end opposite the first substrate.

2. The I/O interconnect system of claim 1, wherein the first material comprises a low modulus material selected from polyimides, epoxides, polynorbornenes, polyarylene ethers, and parylenes.

3. The I/O interconnect system of claim 1, wherein the compliant pillar has a height of about 15 to 300 micrometers.

4. The I/O interconnect system of claim 1, wherein the compliant pillar has a length of about 2 to 55 micrometers and a width of about 2 to 55 micrometers.

5. The I/O interconnect system of claim 1, wherein the first substrate has from about 10 compliant pillars to about 500,000 compliant pillars per centimeter squared of the first substrate.

6. The I/O interconnect system of claim 1, further comprising:

a second substrate having at least one compliant socket adapted to receive a compliant pillar, wherein the compliant socket comprises a second material, wherein the compliant socket includes a non-flat top surface at the end opposite the second substrate.

7. The I/O interconnect system of claim 6, wherein the second material comprises a low modulus material selected from polyimides, epoxides, polynorbornenes, polyarylene ethers, and parylenes.

8. The I/O interconnect system of claim 6, wherein the compliant socket has a height of about 5 to 30 micrometers.

9. The I/O interconnect system of claim 6, wherein the compliant socket includes a material that secures the compliant pillar to the compliant socket.

10. The I/O interconnect system of claim 1, wherein the compliant pillar is used as a transverse waveguide that is substantially perpendicular to the first substrate.

11. The I/O interconnect system of claim 10, further comprising an element selected from a diffractive grating coupler disposed on the compliant pillar and a mirror disposed on the compliant pillar.

12. The I/O interconnect system of claim 11, wherein the coupling element is selected from a volume grating coupling element and a surface relief grating coupling element.

13. The I/O interconnect system of claim 6, further comprising an element selected from a diffractive grating coupler disposed within the second substrate and a mirror disposed within the second substrate.

14. The I/O interconnect system of claim 7, wherein the second substrate has from about 10 compliant sockets to about 100,000 compliant sockets per centimeter squared of the second substrate.

15. The I/O interconnect system of claim 1, further comprising a lead disposed upon a portion of the compliant pillar.

16. The I/O interconnect system of claim 15, wherein the lead is a radio frequency lead.

17. The I/O interconnect system of claim 15, wherein the lead is an electrical lead.

18. The I/O interconnect system of claim 16, wherein the first substrate has from about 10 compliant pillars to about 500,000 compliant pillars per centimeter squared of the first substrate.

19. The I/O interconnect system of claim 17, wherein the first substrate has from about 10 compliant pillars to about 100,000 compliant pillars per centimeter squared of the first substrate.

20. A dual-mode optical/electrical input/output (I/O) interconnect system, comprising:

a first substrate having at least one optical/electrical I/O interconnect that includes a pillar transversely extending from the first substrate, wherein the pillar comprises a first material, the first material is optically conductive, and the pillar includes a lead disposed over a portion of the pillar extending from the base of the pillar on the first substrate to the end opposite the first substrate.

21. The I/O interconnect system of claim 20, wherein the pillar is a compliant pillar.

22. The I/O interconnect system of claim 20, further comprising:

a second substrate having at least one socket adapted to receive the pillar and the lead, wherein the socket comprises a second material, wherein the second substrate includes a lead contact that communicatively connects the first substrate and the second substrate through the lead, wherein the second substrate includes an optical contact that communicatively connects the first substrate and the second substrate through the pillar.

23. The I/O interconnect system of claim 22, wherein the second material comprises a low modulus material selected from polyimides, epoxides, polynorbornenes, polyarylene ethers, and parylenes.

24. The I/O interconnect system of claim 22, wherein the socket is a compliant socket.

25. The I/O interconnect system of claim 22, wherein the pillar includes a non-flat tip at an end opposite the first substrate.

26. The I/O interconnect system of claim 22, wherein the first material comprises a low modulus material selected from polyimides, epoxides, polynorbornenes, polyarylene ethers, and parylenes.

27. The I/O interconnect system of claim 22, wherein the first substrate has from about 10 to about 100,000 optical/electrical I/O interconnects per centimeter squared of the first substrate.

28. The I/O interconnect system of claim 22, further comprising an element disposed on an end of the pillar opposite the first substrate, the element selected from a diffractive grating coupler and a mirror.

29. The I/O interconnect system of claim 28, wherein the diffractive grating coupler is selected from a volume grating coupling element and a surface relief grating coupling element.

30. A method for forming a device comprising:

providing a first substrate having at least one optical/electrical I/O interconnect that includes a pillar transversely extending from the first substrate, wherein the pillar comprises of a first material, the first material is optically conductive, and the pillar includes a lead disposed over a portion of the pillar extending from the base of the pillar on the first substrate to the end opposite the first substrate;

providing a second substrate having at least one socket adapted to receive the optical/electrical I/O interconnect, wherein the socket comprises a second material, wherein the second substrate includes a lead contact that communicatively connects the first substrate and the second substrate through the lead, wherein the second substrate includes an optical contact that communicatively connects the first substrate and the second substrate through the pillar; and

causing the socket to receive a portion of the optical/electrical I/O interconnect.

31. A method of aligning substrates, comprising:

providing a first substrate having at least one optical/electrical I/O interconnect that includes a pillar transversely extending from the first substrate, wherein the pillar comprises of a first material, the first material is optically conductive, and the pillar includes a lead disposed over a portion of the pillar extending from the base of the pillar on the first substrate to the end opposite the first substrate;

providing a second substrate having at least one socket adapted to receive the optical/electrical I/O interconnect, wherein the socket comprises a second material, wherein the second substrate includes a lead contact that communicatively connects the first substrate and the second substrate through the lead, wherein the second substrate includes an optical contact that communicatively connects the first substrate and the second substrate through the pillar;

maintaining optical alignment between the first substrate and the second substrate using the optical/electrical I/O interconnect and the socket; and

maintaining electrical interconnection between the first substrate and the second substrate using the optical/electrical I/O interconnect and the socket.

32. A method of directing optical energy and electrical energy, comprising:

providing a first substrate having at least one optical/electrical I/O interconnect that includes a pillar transversely extending from the first substrate, wherein the pillar comprises of a first material, the first material is optically conductive, and the pillar includes a lead disposed over a portion of the pillar extending from the base of the pillar on the first substrate to the end opposite the first substrate;

providing a second substrate having a socket adapted to receive the optical/electrical I/O interconnect, wherein the socket comprises a second material, wherein the second substrate includes a lead contact that communicatively connects the first substrate and the second substrate through the lead, wherein the second substrate includes at least one optical contact that communicatively connects the first substrate and the second substrate through the pillar;

communicating optical energy between the pillar of the first substrate and the optical contact of the second substrate; and

communicating electrical energy between the lead of the first substrate and the lead contact of the second substrate.

33. A method for fabricating a device having at least one compliant pillar comprising:

providing a substrate;

disposing a material onto at least one portion of the substrate; and

removing portions of the material to form at least one pillar on the substrate having smooth sidewalls that are configured at a substantially right angle with respect to the substrate.

34. The method of claim 33, further comprising:

forming at least one lead on a portion of the compliant pillar, wherein the lead extends from the base of the pillar on the substrate to the end opposite the substrate.

35. The method of claim 33, wherein the pillar includes a non-flat tip at the end opposite the substrate.

36. The method of claim 33, wherein the material comprises a low modulus material selected from polyimides, epoxides, polynorbornenes, polyarylene ethers, and parylenes.

37. The method of claim 33, further comprising:

forming an coupling element on the pillar.

38. The method of claim 33, further comprising:

forming about 10 to about 100,000 pillars per centimeter squared on the substrate.

39. An input/output (I/O) interconnect, comprising:

a substrate having at least one compliant pillar transversely extending from the first substrate, wherein the compliant pillar comprises a first material being optically conductive, wherein the compliant pillar includes a lens disposed at the end opposite the first substrate, wherein the lens being adapted to focus optical energy.

40. A device, comprising:

a substrate including an overcoat polymer layer, a sacrificial polymer layer disposed at a first location between the substrate and the overcoat polymer layer, wherein the sacrificial polymer layer can be removed from the first location to form a compliant polymer bridge.

41. The device of claim 40, further comprising a pillar disposed on the compliant bridge.

42. An input/output (I/O) interconnect system, comprising:

a first substrate having an L-shaped compliant pillar transversely extending from the first substrate, wherein the compliant pillar comprises a first material.